Productive test of a newly drying technology of veneer: intermittent-contact drying of veneer with flexible screen belt

HUA Jun

College of Mechanical and Electrical Engineering, Northeast Forestry University, Harbin 150040, P. R. China

Abstract: A newly drying technology, intermittent-contact drying of veneer with flexible screen belt (ICD-fbs), was invented and used in poplar veneer drying. Productive test was carried out for validating the practical use of this drying method. The test result shows that to dispose flexible screen belts on the two sides of hot board could help steam discharge remarkably. The veneer dried using ICD-fsb method had smooth and level surface, less deformation and warping, even moisture content, and high utilization rate. The time for opening hot board to discharge steam, which, early or late, is a key to obtain good drying result, was determined at the time when the core's temperature of veneer reaches 100 ℃ (vaporization). Using ICD-fsb method, the shrinking rates in tangent of veneer were from 1.90% to 2.26% for veneer of 0.4 mm in thickness, 2.49% to 4.50% for veneer of 1 mm in thickness and 1.34% to 3.30% for veneer of 1.7 mm in thickness, which are much lower than the results obtained by other drying methods. The method of ICD-fsb offers a reliable technological guarantee for solving the deformation problem of veneer drying, especially the deformation of wood from quick-growing plantation.

Keywords Flexible screen belt; Poplar veneer; Drying technology; Veneer drying; Productive test

CLC number: TS652.2 **Document code**: B **Article ID:** 1007-662X(2005)02-0155-03

Introduction

Fast-growing poplar can be used as raw materials for production of plywood, overlaid veneer, stick panel, decorative material, etc.. Veneer drying of fast-growing poplar is one of the key technologies for utilizing effectively fast-growing poplar as industrialized raw materials. Hua (1994) reported a new technology called "two-steep peeling, two-stage drying of veneer" for producing Italian poplar plywood. Zheng (1995) pointed out that if the deformation problem of poplar veneer in drying process was not resolved, it would be unable to produce the acceptable products, and using poplar wood as raw material to produce plywood would have no good future. Many experimental studies had bee carried out on drying method, technology, equipment of poplar veneer (Wang *et al.* 1998; Lu *at al.* 1998; Lu 1992; Bi *et al.* 1990; Le Bois 1987; Sandoe 1983; Milota 1992; Morley 1988; Quarles and Nagoda 1990). These researches established technological foundation for utilizing and developing fast-growing poplar wood as industrialized raw materials.

This study developed a new technology or method for veneer drying of fast-growing poplar, intermittent-contact drying of veneer with flexible screen belt (ICD-fsb), through the experiment and analysis to solve the deformation problem in drying process. The productive experiment was carried out for testing the method. The feasibility and drying quality were appraised for adopting this method.

Materials and method

Experimental materials

The newly fallen poplar trees were cut to veneer with the thickness 0.4–1 mm and 1.6–1.8 mm without pretreatment. The initial moisture content of veneer was 50%–110% for veneer of 0.4–1 mm in thickness and 115%–140% for that of 1.6-1.8 mm.

Equipment

A hot press of 4 layers with vertical feed and a hot press of 8 layers with horizontal feed for producing plywood were used in veneer drying. The test mainly focused on single layer veneer

Flexible screen belt

Two kinds of flexible screen belts, 0.5 mm (meridian) ×0.8 mm (parallel) for thick screen belt and 0.5 mm (meridian) ×0.5 mm (parallel) for thin screen belt, were tested for using in veneer drying. The testing result indicated that the thin screen belt was superior to the thick one in ventilation, and its technical feature also meets instructions for use, thus the thin screen belt was chosen to use in the test of veneer drying. In addition, the necessity for equipping flexible screen belt on the hot board was tested (Table 1). The result indicated that it is effectual to discharge the steam in the drying course of veneer with flexible screen belts. The final moisture content (FMC) of veneer was even, and the tangential shrinking rate was low.

Table 1. Test result of veneer dying with and without flexible screen belt

Screen belt	Thickness of Veneer (mm)	IMC (%)	FMC (%)	Tangential shrinking rate (%)	Distribution of moisture content
With	1.7	110–126	12	3.64	Not even
Without	1.7	110–126	8	1.12	Even

Note: IMC—initial moisture content, FMC—Final moisture content

Under the same experimental condition, the drying speed is fast, thus it is very essential to add flexible screen belt on the hot board. Furthermore, test on disposition of flexible screen belt was also carried out. Flexible screen belts were disposed on two sides of the hot board for one situation and on one side for the other. The result showed that for disposing flexible screen belt on

Foundtion item: This work is supported by "Xing Huo" Program of the Ministry of Agriculture, P. R. China.

Biography: HUA Jun (1959-), male, professor in the College of Mechanical and Electrical Engineering, Northeast Forestry University, Harbin 150040, P. R. China. E-mail: huajun81@yahoo.com.cn

Received date: 2004-10-09

Responsible editor: Chai Ruihai

two sides of hot board, the dried veneer had lower tangential shrinkage, little deformation and warp (Table 2), compared with that of disposing flexible on one side of hot board. Practical production also proved that disposing flexible on two sides was rational to veneer drying.

Table 2. Test results of veneer drying with flexible screen belts on single side and two sides of hot board

Hot-press drying time (min)	Tangential shrinking rate (%)	
	On two side	on one side
10	0.88	1.1
8	0.99	1.33
7	1.18	1.45
6	1.1	1.67

Note: Thickness of veneer is 1.7 mm, Initial moisture content is 110%–126%, and Final moisture content is 8%.

Inspection of optimal production process conditions

Temperature, pressure, and time for hot-press drying, initial moisture content of veneer, and thickness of veneer all have influence on drying speed and drying quality of veneer. The result of the test showed that under the same experimental condition, the drying time of veneer decreased with the rise of hot-press drying temperature (Table 3). Hot-press drying time increased with the growing thickness of veneer (Table 4), and it also varied with different initial moisture content of veneer. When the initial moisture content is higher, hot-press drying time is longer, on the contrary, hot-press drying time is short (Table 5). Tangential shrinkage was reduced with the increase of hot-press drying pressure, but shrinking rate of thickness increased with increasing of hot-press drying pressure (Table 6). The time for opening hot board to discharge steam, early or late, produced different results of veneer drying (Table 7). When the temperature at core of veneer reaches 100 ℃ (vaporization), the hot board should be opened immediately to discharge steam and to quickly get rid of free water of top layer, thus raising the drying speed but not affecting the drying quality of veneer. Under the same experimental condition, the drying results of veneer by continuous hot-press drying and intermittent hot-press drying were obviously different (Table 8). The drying quality of veneer by intermittent hot-press is superior to that by the continuous hot-press.

Table 3. Variation of veneer drying time under different hot-press drying temperature

HPD Temp. (℃)	IMC (%)	FMC (%)	Thickness of veneer (mm)	Hot-press drying pressure (MPa)	Drying-Time (min)
110	110~126	8	1.8	0.5	6.5
120	110~126	8	1.8	0.7	5
140	110~126	8	1.8	0.5	2.5

Note: HPD—Hot-press drying; IMC---Initial moisture content; FMC—Final moisture content

Table 4. Variation of veneer hot-press drying time for different thickness of veneer

Thickness (mm)	HPD temp. (℃)	Pressure (MPa)	IMC (%)	FMC (%)	Time (min)	Tangential shrinkage (%)
0.4	120	0.1	50–110	<6	0.5	2.26
0.4	120	0.1	50–110	<6	0.83	1.90
1	110	0.25	50–110	6~8	2	4.50
1	110	0.5	50–110	6~8	2	2.49
1.7	120	0.5	115–140	6~8	5	3.30
1.7	120	0.5	115–140	6	6	1.34

Note: HPD—Hot-press drying; IMC---Initial moisture content; FMC—Final moisture content

Table 5. Variation of veneer hot-press drying time for different initial moisture content

Initial moisture content (%)	Thickness of Veneer (mm)	Hot-press drying temperature (℃)	Pressure (MPa)	Hot-pres drying Time (min)
126	1.6	120	0.7	6
114	1.8	120	0.7	5
138	1.8	100	0.5	10

Table 6. Variation of veneer shrinkage rates under different hot-press drying pressure

Pressure (MPa)	Initial moisture content (%)	Shrinking rate (%)	
		Tangent	Thickness
0.15	114–140	2.1	1.69
0.70	115–140	1.66	10.81

*Thickness of Veneer is 1.7 mm. Hot-press temperature is 120℃. Time is 5 min.

Table 7. Influence of hot-board open time on hot-press drying time and shrinkage rate of veneer

Hot board open-time (min)	Temperature (℃)	Pressure (MPa)	Final moisture content (%)	Hot-press drying time (min)	Shrinking rate (%)	
					Tangent	Thickness
0.67	118	0.3	8	3.5	1.86	2.20
1	120	0.25	6–8	5	0.62	2.90
1.5	120	0.25	12	5	1.42	2.35
2	120	0.25	6~8	5	1.00	3.90

*Thickness of Veneer is 1.7 mm. Initial Moisture content is 100%~140%.

Table 8. Influence of continuous or intermittent hot-press drying on veneer drying quality

Hot-press way	Hot-press drying temperature (℃)	Pressure (MPa)	Final moisture content (%)	Time(min)	Shrinking rate (%)	
					Tangent	Thickness
Intermittent	118	0.65	8	3.5	1.86	2.2
Continuous	118	0.65	10	3.5	2.06	5.06
Intermittent	138	0.20	6~8	2.5	2.12	1.71
Continuous	138	0.20	8~10	2.5	2.22	1.62

*Thickness of Veneer is 1.7mm

Appraisal of the drying quality of veneer

Under the same conditions such as drying temperature, pressure, initial moisture content of veneer and thickness of veneer, by adopting the method of intermittent-contact drying of veneer with flexible screen belt (ICD-fsb), the tangential shrinking rates of veneer were from 1.90% to 2.26% for veneer of 0.4 mm in thickness, 2.49% to 4.50% for veneer of 1 mm in thickness and 1.34% to 3.30% for veneer of 1.7 mm in thickness (Table 4), which are much lower than the results obtained by Wang (1998) using air convection drying method and indigenous method (air convection: 1.01 mm veneer is from 6.79% to 8.88%, 2.02 mm veneer is from 5.86% to 7.72%; heat brick bed drying: 1.7 mm veneer is 5.56%). The veneer dried by the method of ICD-fsb had smooth and level surface, less deformation and warping, even moisture content, and high utilization rate, especially for the thin veneer (less than 0.4 mm) used for surface layer, and the drying quality was much better. The damaged rate of the veneer, dried with ICD-fsb was reduced greatly compared with the other two dry methods (air convection and heat brick bed drying).

Shrinking rate in tangent of veneer by continuous hot-press drying was lower than that by intermittent hot-press drying, but shrinking rate in thickness of veneer of the former is higher than the latter (Table 9). Veneer drying with ICD-fsb had good result in discharging steam at the middle of veneer, and moisture content of veneer is even after drying, with only approximately 2% difference in moisture content between heart part and edge part of veneer, while the difference in moisture content between heart part and edge part of veneer was about 8% for the veneer drying without the flexible screen belt. It is concluded that the function of flexible screen belt on discharging steam is good and the result is remarkable.

Table 9. Shrinking rates in tangent and thickness of veneer by continuous and intermittent hot-press drying

Hot-press way	Temperature (℃)	Pressure (MPa)	Time (min)	Final moisture content (%)	Shrinking rate (%)	
					Tangent	Thickness
Intermittent	118	0.5	3.5	8	2.24	2.20
Continuous	118	0.5	3.5	10	2.06	5.06
Intermittent	138	0.3	2.5	6~8	2.12	4.92
Continuous	138	0.3	2.5	8~10	2.08	9.90

*Thickness of Veneer is 1.7 mm, Initial Moisture content is 126%.

The productive test indicates that determining rationally the time of hot board opening and discharging steam contributes to improving drying speed and quality of veneer. It is the best time to open the hot board when the temperature at core of veneer reaches 100 ℃ (vaporization) to form a temperature gradient, moisture content gradient, and a steam pressure gradient in the twinkling of an eye, which helps getting rid of the free water of veneer top layer. When the moisture content of veneer drops to the fiber-saturation point (moisture content 30%), the hot board should be closed to help dispel the various stresses produced and improving the quality of the dryness of veneer.

Conclusion

The method of ICD-fsb offers a reliable technological guarantee for solving the deformation problem of veneer drying (especially the deformation of quick-growing plantation). Considering the good drying quality of veneer and the considerable economic benefits we anticipate that this kind of drying method of veneer has wide application prospects. This method had already obtained the national patent for invention in China in 2003 (Patent No.: 98121006.6)

References

Bi Kexin *et al.* 1990. Study on drying technology of veneer [J]. Journal of Northeast Forestry University, **18**(6):54–60. (in Chinese)

Cai Jiabin *et al.* 1998. Effects of press-drying technology factors on fast-grown wood properties & drying quality [J]. Forest Industry, **25**(1): 18–25.

Hua Yukun, Fu Feng, 1994. The technological characteristics of Italian poplar used to produce plywood [J].Forest Industry, **21**(4): 25–27.(in Chinese)

Le Bois. 1987. Continue contact veneer dryer [J]. Scierie-Exploitation Forestiere, **10**: 18–19.

Lu Renshu, Hua Jun, 2003. Vaporizing contact-intermittent veneer drying. China patent: 982368615.

Lu Renshu, Hua Jun, Xu Qiulin. 2003. Veneer drying method of contact-intermittent type with flexible screen. China patent: 98121006.6.

Lu Xiaobao. 1992. A kind of drying method of veneer that is worth trying-hot press drying [J]. Forestry Industry, **4**: 16–19.

Sandoe, M.D. 1983. Gluability of platen-dried veneer of Douglas fir [J]. Forest Prod. J., **33**:7–8.

Milota, M.R. 1992. Applied drying technology 1988 to 1993 [J]. Forest Prod. J., **42**(5).

Morley, P.M. 1988. Continuous press drying for face veneers [J]. Forest Ind., (US), **115**(4):27.

Quarles, S.L. Nagoda, L. 1990. Performance of vented and non-vented cauls in press drying [J]. Forest Prod. J., **40**(11/12): 57–6.

Wang Jin lin *et al.* 1998. Drying of poplar veneer [J]. Wood Industry, **12**(5).

Zheng Rongxuan. 1995. The technical research that poplar produced plywood [J].Forestry Industry, **22**(3):16–17. (in Chinese)

Zhao Xiaomao, Zhang Dishu. 1998. A study on platen dried sliced veneers from small-diameter logs of birch and oak [J].Wood Industry, **12**(2).